the first and second components and being in quadrature. A detector arrangement is provided for receiving and detecting the first and second exiting components from the adaptive beam combiner

Remarks:

In the official action the Examiner begins by making several objections to the specification due to certain informalities. The Examiner is thanked for the careful reading which the Examiner evidently made of the specification. As the Examiner will note by reference to the amendments made above, the suggestions made by the Examiner have been carried out.

The Examiner also noted an informality in claim 8 and that has been corrected, as the Examiner will note by reference to the amendments made above. However, the Examiner's objection to claims 9 and 10, is believed to be in error. The antecedent for "said sonic vibrations" can be found in line 1 of claim 6.

With respect to the Examiner's objection to claim 12, instead of changing "combiner" to "splitter", all of the references throughout the claims to "adapted beam splitter" have been changed to --adaptive beam combiner--. The reason for this is that the term "adaptive beam combiner" is used throughout the specification to refer to element 140. However, there is no "adaptive beam splitter" mentioned in the specification, outside of the claims. As the Examiner no doubt realizes, the element 140 disclosed by the specification and claimed in claims 1 and 11, for example, includes both a combining function and a splitting function; however, given the fact that the term "adaptive beam combiner" is used throughout the specification and on the drawings, the applicants have elected to use this terminology in the claims as well for consistency's sake. As such, instead of amending claim 12 as suggested by the Examiner, the applicants have instead elected to amend claim 11 so that the "adaptive beam splitter" is referred to by the term "adaptive beam combiner" instead. This change does not have any effect on the scope of the

claims.

The Examiner rejected claim 2 under U.S.C. 112 second paragraph as allegedly being indefinite. The Examiner states that he finds it unclear whether the "beam director" and "beam splitter" are the same component.

The "beam director" recited in claim 2 reads upon polarizing beam splitter (PBS) 36 disclosed in the specification. As the Examiner will note by reference to page 6 line 14 of the application, the term "beam director" is used to refer to PBS 36. The claimed "beam splitter" is supported, on the other hand, by element 120 which is referred to as a "beam splitter" at page 7 line 6 of the specification. These elements are shown, for example, in Figure 2. The Examiner's respectfully requested to review Figure 2 and upon doing so, the Examiner will note that the beam director receives a laser beam from the probe laser and directs a first component of the laser beam towards the workpiece 10 and directs a second component, together with the first component as reflected from the workpiece 10, to the beam splitter 120, as claimed. As such, the Examiner is respectfully requested to reconsider and to withdraw this grounds for rejection.

The Examiner rejected claims 1, 3-7 and 9-11 under 35 U.S.C. 102 as being anticipated by U.S. Patent 5,909,279 to Pepper. This grounds for rejection is respectfully traversed.

Claim 1 recites, among other things, an "adaptive beam combiner". As the Examiner will note by reference to the specification, an adaptive beam combiner can comprise a two wave mixer, a double-pumped phase-conjugate mirror or a closed-loop adaptive optical system. See page 7, lines 15-17 in the specification. A two wave mixer can be in the form of a "bulk photorefractive crystal." See page 8, lines 5 - 7. For each of these alternatives, the two multimode beams, 135, with electric field intensities S_1 and S_2, respectively, are combined, resulting in a wavefront-matched pair of output beams 150-155. See page 7, lines 18 - 20.

Photorefractive materials are described in the article "The Photorefractive Effect" which was published by Scientific American in October 1990 (copy enclosed). The effect of an adaptive beam combiner goes far beyond the effect of a simple optical coupler. First, an adaptive beam combiner can be set up so that the output beam will consist of the pair of input beams, with the input beams possessing a 90° phase shift difference between them; that is, they can be made to be in quadrature with each other (the other output beam will also consist of the input beams in quadrature, but with the opposite sign). This quadrature condition is useful for coherent detection systems, since this condition gives the greatest coherent detection system sensitivity. Second, an adaptive beam combiner maintains this quadrature condition even as the beams' phase drifts over time (the response time is a function of the material and the incident optical intensity), which enables the system to always maintain its optimal sensitivity even under dynamic perturbations. An ordinary beam splitter or coupler cannot do this – that is, establish a 90° phase shift between the beams, which is automatically set and maintained over time.

In addition, an adaptive beam combiner provides a pair of output beams, with the first output beam possessing a spatial optical wavefront which is identical to that of the first input beam (even though the photons in the first output beam are derived from both input beams), and the second output beam possessing a spatial optical wavefront which is identical to that of the second input beam (even though the photons in the second output beam are derived from both input beams). As an example, if one of the input beams is a plane wave and the other input beam is a diverging (i.e., a spreading) beam, then, after striking the adaptive beam combiner, the first output beam will be a plane wave (with photons from both input beams), while the second output beam will be a diverging beam (with photons from both input beams). The device is "adaptive" in that it will do this operation even if the wavefronts of the input beams are changing as time goes bye. Thus, if the diverging beam begins to become highly distorted, one of the output beams will assume this same distortion (again, even though those photons are derived

from both input beams). This feature is important for coherent detection, which requires that both beams to be coherently detected have the same wavefronts. Thus, each respective detector placed at each of the output ports of the adaptive beam combiner, will "see" matched wavefronts individually (even though the wavefronts at the first detector may be different than those at the second one, which doesn't matter). An ordinary beam splitter will produce an output beam at each output port, which has the wavefronts of both beams overlapping, which would dramatically decrease the performance of a coherent detector and render it useless in general (i.e., no detectable signal, if the wavefronts are mismatched by more that a small fraction of an optical wavelength).

The Examiner asserts that Pepper '279 also discloses a adaptive beam combiner which apparently has certain attributes which the Examiner mentions in the sentence bridging pages 3 and 4 of the official action and which the examiner identifies by the numeral 22. With all due respect to the Examiner, the language which the Examiner sets forth in the paragraph bridging pages 3 and 4 of the specification appears to come from applicants' claims as opposed to from Pepper '279. If the applicant is mistaken and the Examiner is quoting language out of Pepper '279, then the Examiner is respectfully requested to point out, with particularity, where this teaching can be found in the '279 patent.

Indeed, element 22 of Pepper '279, to which the Examiner makes reference, is not an adaptive beam combiner.

It is respectfully submitted that a person skilled in the art who read the present application, would realize that an adaptive beam combiner has certain attributes, mentioned in the specification, but which are not disclosed in the '279 patent. Element 22 therein is merely an optic coupler. As the Examiner will note, the adaptive beam combiner receives a first component from the beam splitter and a second component with a delay imposed thereon by the optical

delay device. The adaptive beam combiner has two exiting optical components, which are in phase quadrature. Device 22 of the '279 patent is not an adaptive beam combiner and it certainly does not meet the limitations of claim 1 with respect to the two exiting optical components.

Claim 1 has been amended to correct the description of the two exiting beams. The amended language of claim 1 (and the last paragraph of page 3 of the specification) is taken from the specification at page 7, lines 21 and 23.

Turning now to claim 6, claim 6 has been amended to indicate that the adaptive beam combiner (originally called an adaptive beam splitter in some of the claims), receives at least a portion of the scattered first beam and the delayed second beam and emits two beams which are the adaptive beam combiner emitting two beams which are in phase quadrature.

In the Examiner's analysis of claim 6, the Examiner appears to refer to Element 52 as reading upon the originally claimed adaptive beam splitter (now called an adaptive beam combiner to be consistent with the specification). However, it is to be noted that the adaptive beam combiner/splitter combines two incoming beams and emits two outgoing beams. It is not seen how the Examiner can read that functionality on either elements 22 or 52, neither of which are disclosed as being an adaptive beam combiner (or splitter) in Pepper '279. As such, the Examiner's rejection of claim 6 is respectfully traversed.

Turning to the Examiner's rejection of claim 11, claim 11 recites an adaptive beam combiner (originally called an adaptive beam splitter) having a receiving surface for receiving at least a portion of said scattered first light beam and for receiving a second light beam for interfering in the first and second light beams to introduce a phase difference between the first and second beams and for producing copropogating light beams comprising a first portion of said first beam and at least a portion of said second beam. How are these limitations met by Pepper '279? These

limitations are certainly not met by either elements 22 or 52 disclosed in Pepper '279. As such, the Examiner's rejection of claim 11 is respectfully traversed.

The Examiner also rejects claims 1-12 in this application under 35 U.S.C. 103 as allegedly being obvious over U.S. Patent 5,894,531 to Alcoz. This grounds for rejection is respectfully traversed.

First, it is submitted that Alcoz does not teach either an adaptive beam combiner/splitter. In making this rejection, the Examiner basically ignores that point, but goes on to assert that Alcoz does not expressly disclose the two exiting optical components from the beam combiner having certain characteristics. Frankly, this is not to surprising, given the fact that Alcoz does not teach an adaptive beam combiner. Nevertheless, continuing on with the Examiner's logic, the Examiner asserts that it would have been obvious to one having ordinary skill in the arts at the time the invention was made to configure these components "in such a manner." Of course, the applicant disagrees with this assertion, since the components disclosed in Alcoz would not give rise to an adaptive beam combiner/splitter as a person reading the present application would understand that term.

Moreover, what teaching is the Examiner relying on in making this assertion? If it is based on his personal knowledge, then the Examiner is requested to produce the affidavit required by 37 CFR 1,104(d)(2). If the Examiner's relying on a prior art reference, then kindly cite it. Moreover, the Examiner is respectfully requested to explain what the motivation would be to modify Alcoz. The Examiner goes on to assert that "a difference circuit or comparative element could be provided in the place of light dump 8..." why would a person of ordinary skill in the art do that? The light at light dump 8 has no information content. It only has light emanating from the laser after passing through the fifty/fifty beam splitter, the delay line 5 and the polarizing beam splitter 6. The system disclosed by Alcoz is rather inefficient. The system loses an initial 50 percent of the originally generated light at light dump 8 when only one of the two possible

polarizations is passed along to the optical system 9. The light which is reflected off of surface 10 passes back to the optical system 9 and then 50 percent of that light is lost at splitter 4 when it is either returned to laser 1 or sent along to polarizing beam splitter 12.

In any event, light dump 8 just collects the light which is lost initially due to the somewhat inefficient design used by Alcoz. It has no information content since the information content from surface 10 passes the other direction through the polarizing beam splitter 6 in the direction of beam splitter 4 and thence to the detection circuitry at elements 13 and 14.

So, why would a person of ordinary skill in the art be motivated to place a different circuit or comparative circuit in place of light dump 8? Moreover, since the light at light dump 8 is merely the light from the laser, what would it be compared against? Merely substituting a difference or a comparative element in place of light dump 8 would not result in any comparison being made. Moreover, since there is no data there, why do any of this?

With all due respect to the Examiner, it is submitted that the Examiner's analysis is based upon a hindsight reconstruction of applicant's claims, as opposed to a realistic evaluation of how a person skilled in the art might be motivated to modify the disclosure of the Alcoz patent.

If the Alcoz patent calls out for modification, it is because of its inefficiencies, the way it leaks light both in generating the light to the surface 10 and in processing the light reflected off of surface 10. Seventy-five percent of the light is lost in the system disclosed by the Alcoz patent. It is submitted that a person skilled in the art might be well motivated to try to overcome that problem, but how would they do that? It would seem that they would want to get rid of the light dump, as opposed to measuring the light at the light dump.

The Examiner's rejection of the claims under 35 U.S.C. 103 based upon the Alcoz patent is

respectfully traversed. Reconsideration is respectfully requested.

The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, then the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136 (a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

Reconsideration of this application as amended is respectfully requested.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C., 20231 on

October 7, 2002
(Date of Deposit)

RICHARD P. BERG
(Name of Applicant, Assignee or Registered Representative)

(Signature)

October 7, 2002
(Date)

Respectfully submitted,

Richard P. Berg
Attorney for Applicant
Reg. No.: 28,145
LADAS & PARRY
5670 Wilshire Boulevard
Suite 2100
Los Angeles, California 90036
(323) 934-2300

Enclosure
RPB:lilas

APPENDIX A

The third whole paragraph on page 2 of the specification has been amended as follows:

The prior art includes U. S. Patent No. 5,900,935 to Klein et al., which discloses a homodyne interferometer. In this prior art system, an optical beam is directed via two paths to a holographic element. One of the paths includes a sample off which the optical beam is reflected. The optical lengths of the two paths must be kept less than the coherence length of the laser used to illuminate the sample. This restriction [which] imposes strict limitations of the distance which the sample can be from the testing apparatus.

The fifth whole paragraph on page 2 of the specification has been amended as follows:

The prior art also includes isolated two-wave mixers as well as isolated double-pumped phase-conjugate mirrors, both used as real-time beam clean-up (or wavefront matching) elements; these systems degrade in performance in the case of large-amplitude phase excursions, since the real-time grating can experience erasure [in this case].

The first whole paragraph on page 3 of the specification has been amended as follows:

The present invention overcomes all theses limitations, by integrating a high-performance adaptive optical combined element, with a multi-spatial-mode fiber delay line. Moreover, by using a pair of such delay lines, a short-coherence length source can be used; the prior art in this respect involves a photo-emf sensor, which is integrated with the dual-fiber delay line (see Figure 3). T[t]herefore, the net system is limited in detection bandwidth. Finally, the multi-mode optical fiber delay line can be in the form of an amplifying multi-mode optical fiber (e.g., Er-doped glass), for added gain. The present invention will provide robust sensors which can perform in a variety of adverse industrial conditions, including the use of short-coherence sources, extreme (i.e., many optical wavelengths of) workpiece wobbling and beam wander, low-reflectivity workpieces (e.g., or other propagation path losses), and laser amplitude fluctuations (due to workpiece reflectivity changes, wobbling, etc.). The present invention also provides robust sensors for remote sensing and laser communications applications in which the sensor must tolerate fluctuations in received intensity levels.

The last whole paragraph on page 3 of the specification has been amended as follows:

Briefly and in general terms the present invention provides an optical apparatus for coherent detection of an input optical beam. The apparatus includes a beam splitter for splitting the input optical beam into a first component and a second component; an optical delay device arranged to receive the second component, the optical delay device imposing an intentional delay in the second component of the input optical beam; and an adaptive beam combiner coupled to receive the second component with a delay imposed thereon by the optical delay device; and the first component from the beam splitter. The adaptive beam combiner has two exiting components which have the same wavefronts and propagating directions as the first and second components and which are in quadrature [: a first exiting component being representative of the difference of the first and second components received thereby and a second exiting component being representative of the sum of the first and second components received thereby]. A detector arrangement is provided for receiving and detecting the first and second exiting components from the adaptive beam combiner.

The second whole paragraph on page 5 of the specification has been amended as follows:

In a third embodiment, which will be described with reference to Figure 4, the optical source 19 is not provided by laser 18 (which can be omitted), but rather the optical source 19 might be a transmitter of an optical communication system for transmitting data optically. Of course, [the] a suitable laser would likely be used as a component of the optical communications system transmitter.

The paragraph bridging pages 5 and 6 of the specification has been amended as follows:

The first embodiment of the invention will be described in connection with a system and method for detecting ultrasound using time-delay interferometry. However, the invention is not limited to this application as it can also be utilized in other applications, [as] such as communication systems, for example.

The paragraph bridging pages 6 and 7 of the specification has been amended as follows:

When reflected from the surface 16, the probe beam is phase modulated by the vibrations induced on the readout surface 16 by the ultrasound 12. The surface 16 is assumed to be smooth enough so that the reflected probe beam 46 substantially maintains its circular polarization. The reflected probe beam 46 passes back through lenses 44, 40 and 38, and also back through quarter-wave plate 42, which converts this circular polarization back to a linear polarization that is orthogonal to the probe beam's initial linear polarization state as it exited PBS 36. Since the polarization of the reflected beam in now rotated, this rotation allows the reflected probe beam 46 to pass through PBS 36.

The third whole paragraph on page 8 of the specification has been amended as follows:

In Figure 2 a pair of matched detectors 160, 165 are provided that each detect the combined (i.e., wavefront-matched) signals from each of the zero-order and first-order-diffracted output "ports" of the beam combiner 140, so that common-mode (additive noise) can be compensated. The outputs of the detectors 160, 165 are [combiner] combined in an amplifier/processor 170. Lenses L (see Figure 6) can be used between the adaptive beam combiner 140 and the respective detectors 160, 165 to focus the beams emanating from the adaptive beam combiner thereat.

The claims have been amended as indicated below:

1. (Amended) An optical apparatus for coherent detection of an input optical beam, the apparatus comprising:

(a) a beam splitter for splitting the input optical beam into a first component and a second component, the optical beam having information content with a minimum signal frequency component;

(b) an optical delay device arranged to receive the second component, the optical delay device imposing an intentional delay in the second component of the input optical beam;

(c) an adaptive beam combiner coupled to receive

(i) the second component with a delay imposed thereon by the optical delay device; and

(ii) the first component from the beam splitter;

the adaptive beam combiner having two exiting optical components having the same wavefronts and propagating directions as the first and second components and being in quadrature [, a first exiting optical component being representative of the difference of the first and second components received thereby and a second exiting optical component being representative of the sum of the first and second components received thereby]; and

(d) a detector arrangement for receiving and detecting the first and second exiting components from the adaptive beam combiner.

6. (Amended) A method for detecting sonic vibrations in a test material having a test surface comprising:

(a) generating a beam of light having a wavelength;

(b) splitting said beam into a first beam and a second beam;

(c) directing said first beam onto said test surface to be scattered by said test surface with data having a minimum signal frequency component;

(d) delaying the second beam by a period of time which is greater than an inverse of the minimum signal frequency component;

(e) directing at least a portion of said scattered first beam and the delayed second beam on an adaptive beam [splitter] combiner, the adaptive beam combiner emitting two beams which are in phase quadrature; and,

(f) directing [said first and second] the beams emitted by the adaptive beam combiner onto respective photodetectors and associated circuitry to result in an electrical output signal that is representative of the vibrating test surface.

7. (Amended) The method of claim 6 wherein said generated beam of light is a polarized coherent light beam and wherein said first and said second beams are co-propagating and co-polarized when impinging said adaptive beam [splitter] combiner.

8. (Amended) The method of claim 7 wherein said first and said second beams are not co-propagating and co-polarized immediately after the second beam is delayed by the delaying step but wherein the first [sand seconds] and second beams are independently subjected to a polarization correcting step to ensure that each of said first and second beams has the same polarization as the other beam.

11. (Amended) An apparatus for sensing sonic vibrations on a material having a test surface, comprising:

(a) a light generating source for generating a coherent, co-polarized beam of light having a

predetermined wavelength;

(b) a beam splitting apparatus for receiving said generated light beam, splitting said generated light beam into at least a first light beam and a second light beam, and for directing said first light beam to a test material test surface capable of at least scattering said first beam with data having a minimum signal frequency component;

(c) an optical delay device for delaying at least one of said first and second beams with a delay which is greater than an inverse of the minimum signal frequency component;

(d) an adaptive beam [splitter] combiner having a receiving surface for receiving at least a portion of said scattered first light beam at a first angle relative to said receiving surface, and for receiving said second light beam at a second angle relative to said receiving surface which second angle is different from said first angle, for interfering said first and said second beams to introduce a phase shift difference between said first and said second beams, and for producing co-propagating light waves comprising at least a portion of said first beam and at least a portion of said second beam received by said receiving surface; [and,]

(e) photodetectors for receiving co-propagated light beams from said adaptive beam [splitter means] combiner; and

(f) circuitry coupled to the photodetectors for producing an electrical output signal that is representative of the vibrating test surface.

The appendix to the specification has been amended as follows:

An optical apparatus for coherent detection of an input optical beam. The apparatus includes a beam splitter for splitting the input optical beam into a first component and a second component; an optical delay device arranged to receive the second component, the optical delay device imposing an intentional delay in the second component of the input optical beam; and an adaptive beam combiner coupled to receive the second component with a delay imposed thereon by the optical delay device; and the first component from the beam splitter. The adaptive beam combiner has two exiting components having the same wavefronts and propagating directions as the first and second components and being in quadrature [: a first exiting component being representative of the difference of the first and second components received thereby and a second exiting component being representative of the sum of the first and second components received thereby]. A detector arrangement is provided for receiving and detecting the first and second exiting components from the adaptive beam combiner